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The 'Little Ice Age' recorded by sediment chemistry in Lake Erhai, Southwest China

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On the basis of concentrations of 21 major and minor elements in well-dated sediment core from the deepwater part of Lake Erhai, Principal Component Analysis (PCA) reveals three main factors controlling the inorganic chemical composition of lake sediments, which are physical erosion in the watershed (Component 1), autochthonous calcite precipitation in lake water (Component 2) and early diagenesis in sediments (Component 3). Variations of factor scores of Component 1 and Component 3 may respectively reflect fluctuations in rainfall and temperature in the lake region.

During the past 650 years, high factor scores of Component 3 correlate with low factor scores of Component 1 in sediments within AD 1340-1550 and AD 1890-1950, indicating two warm-dry episodes. Low factor scores of Component 3 correlate with high factor scores of Component 1 in sediments within AD 1550-1890, indicating a cold-wet climate corresponding to the 'Little Ice Age' in Europe during AD 1550-1850. Our study provides a new approach of reconstructing paleoclimate, and adds to a growing body of evidence for a widespread cooling during the 'Little Ice Age'.

The basic climate succession type is warm-dry and cool-humid alternately in the region of Lake Erhai, possibly implying different climate change characteristics in the southwest monsoon zone from that in the southeast monsoon zone where the climate pattern is warm-humid and cool-dry in turn. On one hand, the regional climate in Lake Erhai displays concordant variability with the global climate. On the other hand, it takes on specific regional characteristics. To strengthen palaeoclimate study in this region has major significance in revealing climate change characteristics in the southwest monsoon zone and in improving global paleoclimate reconstruction.

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A new MC-ICPMS method for the determination of Cd/Ca ratios in foraminiferal tests

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The Cd/Ca ratios of foraminiferal shells have been used in numerous paleoceanographic studies as a proxy for nutrient utilization and to reconstruct past ocean circulation. A number of results, however, have raised questions regarding the reliability of the Cd/Ca proxy. In order to address such concerns and to evaluate whether the Cd/Ca ratios of tests are altered following deposition, we will conduct a comprehensive calibration study of *in-situ* collected planktic foraminifers on a species level.

The precise determination of Cd/Ca ratios for *in-situ* sampled planktic foraminifers is a challenging task. The amount of sample available for analysis is generally limited. Therefore, the concentration measurements will need to achieve a precision and accuracy of better than 3%, even for samples with as little as 1-5 pg of Cd. To achieve this goal, we have developed new analytical techniques that utilize isotope dilution (ID) and multiple-collector inductively coupled plasma mass spectrometry (MC-ICPMS). Following cleaning and dissolution of the tests, the sample solutions are split. The minor aliquot (5%) is spiked with a ^{43}Ca tracer and the ^{43}Ca/^{44}Ca ratios of the solutions are determined by MC-ICPMS without further separation of Ca. The major aliquot (95%) is spiked with a ^{110}Cd tracer and Cd is separated from the calcite matrix by cation-exchange chromatography. The determination of the Cd abundances then involves the simultaneous measurement of ^{110}Cd, ^{111}Cd, and ^{112}Cd with the triple ion counting system of our MC-ICPMS instrument.

The performance of these methods was verified by analyzing multiple samples of unspiked tests of the planktic foraminifer *Orbulina universa*. The Ca measurements are straightforward and ^{43}Ca/^{44}Ca can be readily determined with a precision and accuracy of better than ±0.15%. The determination of ^{110}Cd/^{111}Cd and ^{110}Cd/^{112}Cd by multiple ion counting yields results that are accurate and precise to better than about ±2% for >1 pg of Cd and better than about 1% for >10 pg Cd. Total procedural Cd blanks are <100 fg. This demonstrates that our techniques are suitable for precise measurements of Cd/Ca ratios in small samples of foraminiferal tests. The methods will, for example, permit the determination of a Cd/Ca ratio of 0.1 µmol/mol with a ±2% precision on 10 µg of calcite tests. We are presently working on extending the analytical techniques, such that further Element/Ca ratios can be determined on the same sample splits.